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Ablaikhanova N.T.[1], Matayeva K.S.[2], Turyskeldi Sh.S.[3], Koyzhigitova M.[4], Ablaikhanova N.T.[5], Tusupbekova G.A.[6], Yesimsiitova Z.B.[7], Gumarova L.Zh.[8]

[1]candidate of biological sciences, acting as associate professor, e-mail: Nurzhanat.Ablaihanova@kaznu.kz
[2-4]master-student, e-mail: kary.95@mail.ru, e-mail: smankizi@mail.ru, e-mail: koijigitovamakpal@gmail.com
[5]master of medical sciences, teacher, e-mail: nurzat7632@gmail.com
[6]candidate of medical sciences, acting as associate professor, e-mail: Gulmira.Tussipbekova@kaznu.kz
[7]candidate of biological sciences, associate professor, e-mail: Zura.Esemciitova@kaznu.kz
[8]candidate of biological sciences, acting professor, e-mail: Lyazzat.Gumarova@kaznu.kz
Al-Farabi Kazakh National University, Kazakhstan, Almaty

CIRCADIAN AND SEASONAL DYNAMICS OF HEMATOLOGICAL INDEXES OF BLOOD OF ANIMALS IN NORM AND AT INFLUENCE OF HEAVY METALS

In this paper, the circadian and seasonal dynamics of hematological blood indices of animals in norm and under the influence of heavy metals are considered. One of the basic principles of the ordering of living organisms is their temporal structure, manifested in the form of rhythmically changing physiological and biochemical processes. Blood as one of the most important systems of an organism, plays an important role in its activity. Therefore any impacts on body tissues affect structure and properties of blood. Considering the explained provisions, need from positions of daily and seasonal dynamics to find out the range of hematological indexes of adaptations of animals in various conditions of dwelling and cultivation at the accruing anthropogenic impact on natural ecosystems, and to investigate reaction of system of blood of animals to influence of ions of heavy metals, that is to reveal features of reaction of system of blood of animals to influence of ions of cadmium, lead, copper and hydrargyrum, and to set the most sensing parameters of blood which can serve as indicators of pollution of the environment heavy metals ripened.

Key words: circadian dynamics, seasonal dynamics, blood, hematological indexes, heavy metals.

Аблайханова Н.Т.[1], Матаева К.С.[2], Тұрыскелді Ш.С.[3], Қойжигитова М.[4], Аблайханова Н.Т.[5], Тусупбекова Г.А.[6], Есимсиитова З.Б.[7], Гумарова Л.Ж.[8]

[1]биология ғылымдарының кандидаты, доцент міндетін атқарушы, e-mail: Nurzhanat.Ablaihanova@kaznu.kz
[2-4]магистратура студенті, e-mail: kary.95mail.ru, e-mail: smankizi@mail.ru, e-mail: koijigitovamakpal@gmail.com
[5]медицина ғылымдарының магистрі, оқытушы, e-mail: nurzat7632@gmail.com
[6]медицина ғылымдарының кандидаты, доцент міндетін атқарушы, e-mail: Gulmira.Tussipbekova@kaznu.kz
[7]биология ғылымдарының кандидаты, доцент, e-mail: Zura.Esemciitova@kaznu.kz
[8]биология ғылымдарының кандидаты, профессор міндетін атқарушы, e-mail: Lyazzat.Gumarova@kaznu.kz
әл-Фараби атындағы Қазақ ұлттық университеті, Қазақстан, Алматы

Қалыпты жағдайдағы және ауыр металдардың әсерінен кейінгі жануарлар қанының гематологиялық көрсеткіштерінің циркадиандық және айлық ырғақтары

Осы мақалада жануарлардың гематологиялық қан көрсеткіштерінің циркадиандық және маусымдық ырғақтары қалыпты жағдайда және ауыр металдардың әсерінен кейін қарастырылады. Тірі организмдердің жүйелеудің негізгі ұстанымдарының бірі олардың түрлі физиологиялық және биохимиялық процестердің ырғақты өзгеруінде көрінетін уақытша құрылымы болып табылады. Қан дененің ең маңызды жүйелерінің бірі болып табылғандықтан, оның өмірінде маңызды рөл атқарады. Сондықтан, тіндерге әр түрлі әсерлер қан құрамы мен қасиеттерінде көрсетіледі. Мәлімделген ұстанымдарды ескере отырып, әр түрлі жағдайларда тіршілік ету және табиғи

экожүйелерге өскелең антропогендік әсер ету жағдайында өсіру тәуліктік және маусымдық ырғақтар жағынан жануарлардың гематологиялық бейімделу ауқымын анықтау және жануарлар қан жүйесінің ауыр металл иондарының әсеріне жауабын тергеу қажеттілігі туындады, яғни жануарлар қан жүйесінің кадмий, қорғасын, мыс иондарының әсеріне жауап ерекшеліктерін және қоршаған ортаны ауыр металдармен ластауының көрсеткіштері бола алатын ең сезімтал қан параметрлерін айқындау қажеттілігі туындады.

Түйін сөздер: циркадиандық ырғақтар, маусымдық ырғақтар, қан, гематологиялық көрсеткіштер, ауыр металдар.

Аблайханова Н.Т.[1], Матаева К.С.[2], Турыскелды Ш.С.[3],
Койжигитова М.[4], Аблайханова Н.Т.[5], Тусупбекова Г.А.[6],
Есимсиитова З.Б.[7], Гумарова Л.Ж.[8]

[1]кандидат биологических наук, исполняющая обязанности доцента, e-mail: Nurzhanat.Ablaihanova@kaznu.kz
[2-4]студент магистратуры, e-mail: kary.95@mail.ru, e-mail: smankizi@mail.ru, e-mail: koijigitovamakpal@gmail.com
[5]магистр медицинских наук, преподователь, e-mail: nurzat7632@gmail.com
[6]кандидат медицинских наук, исполняющая обязанности доцента, e-mail: Gulmira.Tussipbekova@kaznu.kz
[7]кандидат биологических наук, доцент, e-mail: Zura.Esemciitova@kaznu.kz
[8]кандидат биологических наук, исполняющая обязанности профессора, e-mail: Lyazzat.Gumarova@kaznu.kz
Казахский национальный университет им. аль-Фараби, Казахстан, Алматы

Циркадианная и сезонная динамика гематологических показателей крови животных в норме и при воздействии тяжелых металлов

В данной работе рассмотрена циркадианная и сезонная динамика гематологических показателей крови животных в норме и при воздействии тяжелых металлов. Одним из основных принципов упорядоченности живых организмов служит их временная структура, проявляющаяся в виде ритмически изменяющихся физиологических и биохимических процессов. Кровь как одна из важнейших систем организма играет важную роль в его жизнедеятельности. Поэтому всякого рода воздействия на ткани организма отражаются на составе и свойствах крови. Учитывая изложенные положения, назрела необходимость с позиций суточной и сезонной динамики выяснить диапазон гематологических показателей адаптаций животных в различных условиях обитания и выращивания при нарастающем антропогенном воздействии на природные экосистемы, и исследовать реакцию системы крови животных на воздействие ионов тяжелых металлов, то есть выявить особенности реакции системы крови животных на воздействие ионов кадмия, свинца, меди и ртути, и установить наиболее чувствительные параметры крови, которые могут служить индикаторами загрязнения среды тяжелыми металлами.

Ключевые слова: циркадианная динамика, сезонная динамика, кровь, гематологические показатели, тяжелые металлы.

The rhythm is one of living conditions of alive organisms and reflects the adaptive nature of self-regulating biosystems. Biorythmological and related high-quality changes with various methods are revealed at all levels: molecular, subcellular, cell-like, organ, systemic. In particular, the hemopoiesis alternation at different types of animals for days, a row of days and seasons of year is established. At the same time there are no data on rhythm of formulated elements in peripheral blood, enzymes, the common protein and proteinaceous fractions in blood serum serving as criterion for evaluation of the functional condition of an organism of animals (Tagirov, 2011: 114-116).

Being in close contact with fabrics, blood has all jet properties of fabrics, but its sensitivity to pathological irritations is higher and thinner, and the reactivity – is more expressive and more boldly. Therefore, one of the major tests at the characteristic of a look are the blood given on features – the most available to a research of the fluid fabric which is influenced influence of both external, and internal factors, fabric which substantially characterizes wellbeing of an organism as whole. Therefore the hematological analysis as one of methods of clinical diagnostics, found broad application in biology and medicine (Krylov, 2009: 121-125).

Increase in production of livestock products cannot be reached without knowledge of biology of development of animals, widespread introduction of new scientifically based technologies of contents and feeding, without the exact organization of events on fight against diseases. Biological (fundamental) knowledge of development is the cornerstone of medical, veterinary and agricultural sciences.

The effectiveness of agricultural production in many respects depends on integration of various sciences and practical livestock production. Experts, cattle breeders need from scientists legible evidence-based recommendations: on increase in efficiency; efficient organization of works on a breeding of economic breeding herd; on maintenance, feeding,

safety and adaptation of young growth (Kosilov, 2009: 150-158).

One of the reasons of decrease in quantity of livestock production is poor knowledge of the physiological mechanisms of adaptation of an organism providing development of animals, especially at young age. All functions of an organism are carried out rhythmically and depend on the composite system of biorhythms as on organ and fabric, cell-like, and on a molecular scale. Influence of biological rhythms on life and development of each organism is recognized and is used in the practical purposes. However in literature there are no complete data on hour, daily biorhythms of body height and development of farm animals. It constrains use of a biorythmology in practical livestock production and veterinary medicine (Irgashev, 2014: 89-91).

Profound studying of composition of peripheral blood gives an idea of the physiological mechanism of adaptation of an organism is base or "norm" for drawing up haemograms at various diseases. Morphological and biochemical indicators are tests of adaptation of an organism to the changing conditions of the internal and external environment.

Among a wide range of rhythms of life the main, basic rhythm, a core of the temporary organization of alive systems is the daily rhythm differing in generality, universality, stability, high stability and regularity (Zakharov, 2002: 4-9).

The absolute quantity of erythrocytes, hemoglobin, lymphocytes and neutrophils in peripheral blood at mice is subject to daily fluctuations. The quantity of eosinocytes at mice increased in the afternoon and decreased at night. Marrow is most active early in the morning when in a blood-groove the greatest number of young erythrocytes with the maximal hemoglobin content comes to the 11-13th: minimum – in the 16-18th (Zinchuk, 2001: 66-78).

By data A.V. Vasilyeva (1948) quantity of leukocytes in blood of animals is less in the morning, than in the evening. By I.F. Lukmanov's researches (1998) it is shown that dynamics of quantity of erythrocytes, leukocytes, the level of a hemoglobin, protein, glucose, activity the AlAT, AsAT, catalases, a lactatedehydrogenase and an alkaline phosphatase of blood serum, peroxidase and phagocytic activity of leukocytes at hens within a day has wavy character.

The total of leukocytes of peripheral blood of monkeys is subject to the considerable, quite particular daily fluctuations. Both at macaques a Rhesus factor, and at baboons of hamadryads in morning and day time of days the quantity of leukocytes decreases; in evening and night hours the quantity them sharply increases in blood. The quantity of segmented neutrophils is considerably increased days in the morning. By the night and morning their number decreases in peripheral blood (Lipunova, 2003: 25-30).

Y. Kondo, U. Gahyaningsihi (1992) was revealed by a daily rhythm of level of monocytes, lymphocytes, phagocytic and bacteriemic activity at chickens. The under levels of monocytes and bacteriemic activity have on morning, and phagocytic activity evening clocks.

In the experiment on rats made by E.V. Kalinicheva and B.B. Varnitsina (1985) studied the maintenance of erythrocytes, reticulocytes, hemoglobin level, daily production and life expectancy and also activity of enzymes of antioxidatic system. On all listed components they revealed statistically significant circadian rhythms.

According to V.P. Latenkov, (1985), at healthy people legiblly expressed daily, frequency is peculiar to hemoglobin level. According to it the highest concentration of this index is noted in the afternoon, a hemoglobin oxygenation most intensively proceeds in the morning.

Yu.A, Temple and A.I. Yerokhin (1999) is established that biochemical indexes of blood serum and factors of humoral nonspecific protection (the common protein, albumins, α-, β-, γ-globulins, the R-lysine) submit to all-physiological regularities of alternation of the functional activity of various systems of an organism, the daily rhythm is inherent in them.

Existence of a particular daily rhythm of adrenocorticotropic function of the hypophysis and bark of adrenal glands caused by photofrequency influence is revealed. This rhythm is expressed in daily fluctuations of maintenance of ACTH in a hypophysis, Acidum ascorbinicum in adrenal glands, leukocytes, eosinocytes and lymphocytes in peripheral blood (Lipunova, 2004: 216).

The available works cover fragmentary daily dynamics only on one research in days. Hour dynamics of morphological indexes in peripheral blood at animals (a hemoglobin content, erythrocytes, a hematocrit, a leukogram) and biochemical indexes (sugar in blood, inorganic phosphorus in plasma, calcium in serum, albumins, alpha, beta, gamma-globulins, the common protein and proteinaceous coefficient) is not studied.

So, the reference changes are undergone within a day by the system of blood: a hemopoiesis in red marrow is most intensive in the morning, the spleen and lymph nodes are most active in 17 – 20 h. The maximal concentration of a hemoglobin in blood

is observed from 11 to 13 o'clock, minimum – at night. Circadianism is characteristic of number of erythrocytes and leukocytes in blood (Zelentsova, 2004: 94-95).

The minimum ESR is noted early in the morning. Since evening in blood the content of serumal proteins begins to decrease. Content of electrolytes of blood serum, fibrillation speed have the reference circadian dynamics. Therefore, practically the circadian rhythm is characteristic of all indexes of blood.

Thus, the daily rhythm is peculiar to many physiological functions of an organism. At the same time there are extremely not enough data on daily dynamics of composition of blood at animals during different seasons of year.

Among numerous biological rhythms biological rhythms, the bound to change of season, are designated as seasonal, or circus rythms, and refer to adaptive. The oscillating character of biological rhythms, the bound to permanent natural factors in the course onto-and phylogenetic development took a form of the endogenic rhythms which are evolutionarily (genetically) fixed.

As for seasonal changes, many rhythms are traced at animals in the form of seasonal changes of functions (hibernation, seasonal changes endocrine, including sexual function etc) (Syroyeshkin, 2002: 35-40).

Seasons exert the expressed impact and are well shown in rhythm of change of functions at many animals.

Various researches of system of blood conducted during all annual cycle demonstrate that the composition of peripheral blood undergoes the considerable seasonal changes.

During the spring and summer period inverse is often observed natural dynamics of a hemopoiesis, and indexes of blood are characterized by the larger range of variation. For example, fluctuations of level of leukocytes are not essential and do not overstep the bounds of physiological norm. Only small increase in frequency of occurrence of pseudoeosinophils and eosinocytes during the spring and autumn periods is usually observed. In the autumn the most high level of erythrocytes in blood of animals is established. Minimum concentration of a hemoglobin and erythrocytes are noted during the summer period. By autumn and winter indicators of red blood increase, concentration of leukocytes – decreases. The CSP (concentrate of serumal protein) level, an ESR (blood sedimentation rate), percent of neutrophils, eosinocytes from summer by winter decrease, and the share of monocytes significantly increases. To spring warming there is on the way of reliable weakening of a hemoglobin, increase in an ESR, the relation Er:l, activization eritro-and a granulopoiesis (Taraktiy, 2007: 14-25).

Important constituent of blood are the proteins performing various functions in an animal organism. The smoothly varying change of content of the common protein in each group on seasons of year was noted. The received results were in limits of physiological norm. It is known that the fullest information is given by a research of proteinaceous fractions as changes in their ratio can happen regardless of the content of the common protein. The maintenance of albumins, as well as the common protein, did not exceed limit of physiological norm. It is established that change of concentration of globulins in blood serum had wavy character on seasons of year. At the same time the least maintenance of α-globulins in blood serum was noted at animals during the autumn period.

Indexes of β-globulins also change within a year. It should be noted that concentration of β-globulins during all seasons of year was in blood serum at a high level.

As for γ-globulins, it should be noted their essential fluctuations depending on a season of year. At the same time their maximum level in blood serum of animals was noted in the autumn, minimum contents was noted during the summer period.

In an animal organism an important role is played by re-amination enzymes: an alanine aminotranspherase (ALT), an aspartate aminotranspherase (nuclear heating plant) which trial function is transfer of an amino group from amino acids to ketonic acids. Increase in activity of ALT happens at animals during the spring period. A similar picture and on activity of nuclear heating plant.

Level of macrocells (calcium and phosphorus) in blood serum is characterized by the relative stability on the periods of a research (Tembotov, 2005: 169-174).

Among the numerous systems of an organism supporting its normal activity, the erythrocyte system has prime value. Concentration of erythrocytes – the important hematological index reflecting a physiological condition of an organism and also opening mechanisms of an adaptive self-regulation of biosystem.

For example, results of multi-day blood analyses of ducks of breed the Bashkir color showed that the level of maintenance of erythrocytes is subject to natural seasonal fluctuations.

Average annual concentration of erythrocytes in peripheral blood at adult ducks of breed the Bashkir color made $2,66+0,063*10^{12}$ a g/l, a hemoglobin

– 130,2+1,82 g/l, leukocytes-28,15+0,44*10^9 g/l. The activity of an alanine aminotranspherase (ALAT) and aspartate aminotranspherase (ASAT) of blood serum corresponded to 0,333+0,011 and 0,320+0,015 mmole/(h*l). Level of the common protein was 47,8+1,7 g/l, at the same time 51,52+0,88 and 48,48+0,77% respectively fell to the share of albuminous and globulinous fractions.

The seasonal rhythm of hematological indexes of ducks of the Bashkir color breed is revealed. The greatest number of erythrocytes – 3,19+0,16*10^{12} g/l, leukocytes – 32,7+0,44*10^9 g/l was observed during the summer period; the common protein – 64,0+4,0 g/l, albumins – 63,03+0,17% – in spring, and a hemoglobin – 142,4+1,91 g/l and γ-globulins – 23,84+0,44% – in autumn. Minimum values of amount of hemoglobin – 118,8+4,27 g/l, γ-globulins – 13,13+0,08% are established during a spring season; erythrocytes – 2,26+0,08* 10^{12} g/l, a squirrel – 35,3+1,2g/l, albumins – 37,04+0,45% – in autumn, and leukocytes-24,6+0,63*10^9 g/l – in winter seasons (p<0,001). The temporary structure of the monthly rhythms of hematological indexes includes fluctuations with the periods about 14 days.

Features of very tectonics of the circadian rhythms of hematological indexes of ducks during different seasons of year are established. During the spring period the least basic level, a vibration swing of the circadian rhythms of the quantitative indices of a hemoglobin, γ-globulins and activity of ASAT enzyme of blood serum, and at the same time maximum basic level of fluctuations of erythrocytes, the common protein and albumins is shown. The least basic level of maintenance of leukocytes, the common protein, albumins is the share of autumn.

High reliable correlative communication is noted between a protein of muscular tissue and leukocytes (r=-0,80), a hemoglobin of peripheral blood (r=0,76), aspartate aminotranspherase (r=-0,70), the common protein (r=-0,67), β-globulins of blood serum (r=0,60); between fat of pectoral muscles and erythrocytes (r=-0,82), a hemoglobin (r=0,77), leukocytes of peripheral blood (r=-0,97).

High reliable correlative communication is revealed between the air temperature and leukocytes of peripheral blood (r=0,71); between the relative humidity of air and albumins (r=-0,91), globulins (r=0,89) of blood serum of ducks.

The maintenance of erythrocytes on seasons of year was the following: in the spring – 2,47+0,121* 10^{12} g/l; in the summer-3,19+0,157* 10^{12} g/l; in autumn – 2,26+0,076* 10^{12} g/l; in the winter – 2,69±0,066* 10^{12} g/l. Level of erythrocytes during a summer season of year was authentically above than in spring (p <0,001), in winter above, than in autumn (p<0,001), and in autumn below, than in summer (p <0,001).

Notes: p <0,05; p <0,01; p <0,001-interseasonal distinctions.

The reliability of interseasonal distinctions was defined when comparing values of indexes of two interfacing seasons of year.

During the spring and autumn periods the value of an index was reliable below average annual on 7,1 (p <0,05) and 15% (p <0,001) respectively, and in summer and winter, on the contrary, is 19,9% higher (p <0,01) and 1,1% (p <0,05).

The minimum content of erythrocytes in peripheral blood is observed in the autumn, and maximal – in the summer (p <0,001). Apparently, seasonal changes of heliogeophysical factors by means of modulation of activity of sympaticoadrenal system define natural reaction of an erythrogenesis. The highest rates of blood are observed in the period of an optimum combination of factors of the external environment.

The special attention is deserved by studying of character, size and structure of variability, various physiological and biochemical properties of an organism as data such are necessary for physiology as on their basis the normative values reflecting a condition of animals in the changing environment conditions can be defined.

The greatest vibration swing of concentration of erythrocytes and also variation factor of the studied index falls on the spring and summer periods that can demonstrate the greatest lability of system and speak features of the endocrine status at this time. So, in the spring the level of erythrocytes fluctuates from 1,21 to 3,80, at average monthly value 2,47+0,121*10^{12} g/l and CV=26,8%, and in the summer from 1,62 to 4,62* 10^{12} g/l, at CV=26,9%.

The least vibration swing and variability of an index is observed during a winter season and makes 1,36*10^{12}g/l and 13,5%, with an average 2,69+0,066*10^{12} g/l. In the autumn the variability of level of erythrocytes is intermediate between spring and summer and winter levels.

Analysis of the dynamics of erythrograms revealed characteristic changes confirming the existence of a circus rhythm.

One statistically significant maximum (p<0,001) is clearly discernible, manifested in the summer season and two minimums corresponding to the spring and autumn periods (p <0,001).

Despite sufficient informational content of statistics, they do not reflect the nature of changes of level of erythrocytes of peripheral blood in time.

Change of level of erythrocytes has wavy character.

The vector of the direction of the monthly rhythms has a positive value in the spring; autumn; winter periods and negative in the summer. The maximum basal level (acrophase) is observed in summer, and the minimum (batiphase) is in autumn. The size of a vibration swing of average values of the studied index is maximum during spring and summer seasons and is percentage of minimum value 67 and 84 of % respectively. In the fall and in the winter the difference between minimum and maximal value expressed percentage of minimum is equal to 37 and 31% respectively.

During the spring and summer period of the experiment, there is a pronounced tendency to increase the concentration of red blood cells in black white-chested ducks in comparison with the khaki color by 7,4 and 2,8%. In the autumn and winter seasons, the prevalence of this indicator in ducks of khaki was 6,4 and 9,7%, while the difference in winter was significant ($p < 0,05$). The magnitude of the amplitude of the oscillations is maximal for black white-chested ducks and khaki in the summer season and is, as a percentage of the minimum value, 133 and 170%, respectively. In spring, autumn and winter, the difference between the minimum and maximum values expressed as a percentage of the minimum in black white-chested ducks is 214; 54 and 68%, and khaki ducks – 148; 116 and 36% respectively.

Daily rhythm of concentration of erythrocytes, hemoglobin and leukocytes in peripheral blood of ducks during different seasons of year: as adaptation to seasonal environmental changes serve not only the seasonal rhythms, but also adaptive changes of activity of daily rhythms which are shown at animals by appropriate time of year.

The daily recurrence of concentration of erythrocytes in peripheral blood of the Bashkir color ducks is revealed.

The size of a vibration swing of all studied indexes in particular time of day was determined as the difference of the maximal and minimum individual value this hour. The average daily vibration swing of all studied indexes made the difference of the maximal and minimum individual value registered within a day.

The average daily maintenance of erythrocytes in peripheral blood of ducks of breed Bashkir color on seasons of year was the following: in the spring-$3,02 \pm 0,09 * 10^{12}$ g/l; in the summer – $2,25+0,13 * 10^{12}$ g/l; in the autumn – $2,28+0,09 * 10^{12}$ g/l.

The greatest variability of sign is observed during the summer period of-27,8%, and the least – in spring – 16,0%.

Comparative analysis of statistical indicators of ducks of different types showed that the highest average level was observed in the spring season and is $3,33+ 0,09 * 10^{7}$ g/l for black white-chested ducks and $2,72+ 0,12 * 10^{12}$ g/l for khaki ducks. In the summer and autumn periods, the average values around which fluctuations occur are approximately at the same level of $2,20\text{-}2,32 * 10^{12}$ g/l.

Thus, the level of erythrocytes has distinct daily frequency. The appearance of concentration curves of erythrocytes at ducks of different types coincides. The highest content of erythrocytes is noted at 15 o'clock in the spring, then gradually decreases, reaching a minimum to 03 h. In the summer the size of this index is maximum at 15 o'clock, and is minimum in 21 h. Concentration of erythrocytes in autumn time goes down in night-time.

The greatest range of diurnal fluctuations was found in the summer period and is 57,1; 76,5% of the minimum value for ducks are black-chested and khaki, respectively. This circumstance is associated with the unfavorable exogenous effect of weather conditions, namely, the unstable course of temperature and humidity, observed during the July-August months.

The high degree of manifestation of adaptation of the organism in this period is also evidenced by the splitting of the monophasic circadian rhythm of erythrocytes into a bimodal one. In the spring and autumn periods, the smallest range of diurnal fluctuations is noted, expressed as a percentage of the average minimum value of 15,8; 21,8% in black-chested and 30,7; 62,5% for khaki ducks.

Results of experience allow to characterize also time-dependent years of fluctuation of a hemoglobin content within a day at the Bashkir color ducks. The average daily hemoglobin content at ducks of breed Bashkir color on seasons of year was the following: in the spring – 117,5+3,26 g/l; in the summer of 118,7+4,09 g/l; in the autumn – 123,5±3,34 g/l.

The greatest variability of sign was observed during the summer period. During the spring and autumn periods the variation factor had no essential differences and made 13,6 and 13,3% respectively.

The highest average hemoglobin level was observed in the autumn-spring season and is 123,8 + 4,78 g/l for black white-chested ducks and 123,3 + 4,89 g/l for khaki ducks. The lowest average level was found in the spring and made for black, white-chested ducks and ducks khaki -115,4 + 3,48 g/l and 119,5 + 5,63 g/l, respectively. The average value of

the indicator under discussion in the summer period occupied an intermediate position between spring and autumn.

Communication of fluctuations of morphological and biochemical indexes of blood with recurrence of geophysical factors one of the functional regularities of the Universe – existence of natural cycles (rhythms) caused by astronomical phenomena. Thanks to rotation of Earth round its pivot-center (terrestrial days, or 24 hours) and also to the address around the Sun on an elliptic orbit (about 365 days or terrestrial year) happen become critical for people of Earth change of day and night with the contrasts of illuminating intensity accompanying them, change of seasons of year (winter, spring, summer, autumn) to changes of weather conditions. Therefore, natural rhythms cannot but affect a state alive on Earth.

It is well-known that in the course of evolution at animals the mechanisms providing thin adaptation of an organism to constantly changing environmental conditions were created. Despite extensive knowledge in this question, remains the external environment which is poorly studied connection of rhythms of physiological functions of an organism with periodic vibrations of parameters so far – air humidities, atmospheric pressure, temperature. The solution of these problems has not only theoretical value (provides disclosure of mechanisms of formation of biorhythms), but also practical value because prerequisites for prognostic activity of functions of an organism on the nature of fluctuations of indexes of external factors are created.

When forming seasonal biorhythms of an organism of animals one of key roles is played by a complex of geophysical factors (air temperature, atmospheric pressure, the relative humidity of air).

There are initial coefficients of correlation characterizing communication of morpho-biochemical indexes of blood among themselves and with geophysical factors. Between rhythmic fluctuations of morpho-biochemical indexes of blood the functional interrelation is shown.

Noticeable communication, according to Cheddok's scale, between a hemoglobin and gamma-globulins (r=0,69), the ALAT (r=0,61) is revealed; between leukocytes and a hemoglobin (r=-0,55), albumins (r=0,59), to alpha globulins and (r=-0,55), beta globulins (r=-0,63), gamma-globulins (r=-0,55); between the common protein and beta globulins (r=-0,69); between the ALAT and albumins (r=-0,56); beta globulins (r=0,61), gamma-globulins (r=0,55).

The high size of communication is noted between a hemoglobin and albumins (r=-0,75), alpha globulins (r=0,73), beta globulins (r=0,78); between leukocytes and the ALAT (r=-0,81); between the common protein and albumins (r=0,71), gamma-globulins (r=-0,71).

Very high extent of communication is traced between albumins and alpha globulins (r=-0,96), beta globulins (r=-0,99), gamma-globulins (r=-0,99); between alpha globulins and beta globulins (r=0,94), gamma-globulins (r=0,92); between beta and gamma-globulins (r=0,96).

At the same time, there is a natural communication between variation ranks of hematological indexes and geophysical factors.

Noticeable communication, according to Cheddok's scale, is noted between temperature and erythrocytes (r=0,63), the ALAT (r=-0,61); between the relative humidity of air and hemoglobin (r=0,67), the common protein (r=-0,63).

High communication is revealed between temperature and leukocytes (r=0,71); between the relative humidity of air and alpha (r=0,89), beta (r=0,89), gamma-globulins (r=0,89).

Very highly the relative humidity of air and albumins of blood serum of ducks (r=-0,91) correlate among themselves.

Numerous researches established interrelation of hematological indexes and productive qualities of animals. The correlation between signs can, arise on various genetic basis. Distinguish genomic, morphogenetic and physiological correlations and evolving from genetic-automatic processes of a drift of genes. Also the factors of the external environment causing adequate changes in different signs can be the cause of correlations.

In this regard accounting of correlative communication of hematological and productive indexes of animals significantly increases informational content of the conducted researches as it can be used for prediction of their productive qualities.

In researches communication of seasonal dynamics of hematological indexes and productive qualities of animals is shown initial correlative. Noticeable communication, according to Cheddok's scale, between fat of pectoral muscles and albumins (r=0,64), β-globulins (r=0,70) is revealed; γ-globulins (r=0,61); alanine aminotranspherases of blood serum (r=0,66); between a protein of muscular tissue and the common protein (r=-0,67), albumins (r=-0,53), β – globulins (r=0,60), γ-globulins of blood serum (r=0,58).

The high size of communication is noted between fat of pectoral muscles and erythrocytes

(r=-0,82), a hemoglobin (r=0,77) of blood serum; between a protein of muscles of ducks and leukocytes (r=-0,80), a hemoglobin (r=0,76), an aspartate aminotranspherase of blood serum (r=-0,70); between ashes in muscles and α-globulins (r=-0,61) in blood serum; between nonvolatile solid of muscles and leukocytes (r=-0,84), a hemoglobin (r=0,78) of blood serum.

Thus, existence of communication between hematological indexes and geophysical factors, apparently, indicates their possible participation in formation of the periodical press of a hemopoiesis (Tembotova, 2007: 315-323).

The present stage of development of a civilization is characterized by scales of anthropogenic impact on land and water systems unprecedented still, including on the sphere of agro-industrial production. Intensive impact on natural and agricultural ecosystems worsened the habitat and began to go beyond biological adaptability of organisms.

Special danger of accumulation in the external environment from the point of view of biological activity and toxic properties represent such heavy metals as lead, hydrargyrum, cadmium, zincum, bismuth, cobalt, nickel, copper, tin, antimony, vanadium, manganese, chrome, molybdenum, etc.

It is known that anthropogenic influences can lead an organism of farm animals to an extreme condition and essential change of indexes of a morphofunctional homeostasis. However, data on influence of heavy metals on an organism of animals are very limited. It significantly complicates introduction of pathogenetically reasonable, available and economic measures of complex prophylaxis and treatment of pathology of bodies of reproduction, upgrading of livestock production and safety of young growth in zones of ecological trouble. Therefore, assessment of a morphofunctional condition of an organism of animals taking into account migration of heavy metals in «the soil-vegetable forages – water – an animal-livestock production» system, and also research of paths of a decontamination of the internal environment of an organism from the considered xenobiotics is very current problem of the modern livestock production and demands comprehensive study (Tembotov, 2009: 370-378).

Having stepped over the dawn of the third millennium, the mankind entered a new age of progress, the modern technologies and outstanding achievements, having saved up billions of tons of the industrial wastes polluting and poisoning the biosphere for the last years.

Annually millions of tons of pollutants come to the atmosphere of the cities and settlements from various sources of emissions. As show researches of scientists, anthropogenic loads of natural systems exceeded admissible level, the state of environment is close to loss of equilibrium stability and the biota from the regulator of global ecogeochemical balances turns into the destructive factor. Survival of mankind requires urgent decrease in technogenic loadings.

The greatest contribution to pollution of free air and other objects of a surrounding medium is brought by the enterprises of a power engineering, mining and processing industry, metallurgical, oil and gas processing and petrochemical productions. In a complex of the substances which are thrown out in a surrounding medium, the essential role belongs to heavy metals that is confirmed by results of analyses of the soil, water and air. High concentrations of toxiferous metals, change of microelement structure of a surrounding medium can lead to emergence of so-called technogenic biogeochemical provinces, violation of protective and adaptive reactions of an organism and emergence of new pathological states (Salakhov, 2014: 206-207).

At present, the important role of trace elements as catalysts for many biological reactions has been established, the essentiality of most of them has been discovered, and the pathogenic effect of many heavy metals on the organism has been revealed.

The researches devoted to features of accumulation of chemical elements in biological substrata from positions of ecological division into districts of the habitat of the person are conducted by a number of authors in recent years, however they are, as a rule, devoted to separate chemical contaminants at rather small set of the analyzed biological environments.

One of the most dangerous chemical toxicants are heavy metals (HM), cumulating in all parts of the trophic chain soil-plants – animals – animal products – people. The pollutant elements for the entire region are lead (Pb), copper (Cu), zinc (Zn), cadmium (Cd), nickel (Ni), cobalt (Co), manganese (Mn) and chromium (Cr) (Gumerov, 2010a: 132-133).

Continuous air pollution by emissions leads to ever-increasing dissimilation of HM and other harmful substances in objects of a surrounding medium, to change of natural structure of soils, reservoirs, vegetable and animal organisms, formation of biogeochemical provinces of anthropogenic origin and increase in daily loading of toxicant at an organism of animals and the person (Gumerov, 2010b: 133-135).

Pollution of potable water and forages leads to accumulation of HM in an organism of animals that

involves serious deviations in a condition of their health: the change of hemato-biochemical indexes, a metabolic disorder, structural violations of bodies and fabrics reaching to necrotic decrease in the common resistance, developing of chronic toxicoses and also makes essential impact on the level of efficiency of animals, a reproductive function and the biological value of the received production (Gertman, 2001: 34-36).

In this regard, the special relevance is acquired by researches on research and use of the modern methods of detoxicating of components of a diet of animals.

The wide experience on application in a delivery of animals various mineral подкормок which show getter properties in relation to HM and other toxins is accumulated, improve a metabolism, remove a condition of toxicosis and increase efficiency (zeolites, casting boxes, vermiculite, diatomites, bentonites and others).

Comparative morphological, biochemical and hematological assessment of the changes happening in an organism of animals in zones to an ecological situation, various on weight, and at introduction to their diet of top dressing sorbent yields reliable distinctive results (Novozhilov, 2006: 239-240).

In a zone with an intense ecological situation according to content in a surrounding environment Pb, Ni, Cu, Zn and Cd compounds in blood of animals of the final stage of sagination increase in quantity of erythrocytes, speeds of their sedimentation, decrease in a fraction of neutrophils, eosinocytes and monocytes is registered, and the relative level of lymphocytes during all experience was on an upper bound of physiological norm.

Biochemical blood analyses of animals on sagination in a zone with an intense ecological situation revealed sharp fluctuations of level of the common protein with decrease in separate months below normative values, low abundance of albumins with the raised fraction of β-globulins, the increased concentration VFA (volatile fatty acids), low level of ketone bodies and sharp fluctuations in the content of the common cholesterol, glucose, NEFA (not esterified fatty acids) and p-lipoproteins.

Morphological studies of the organs of animals in the zone with a strained ecological situation revealed dystrophic in combination with hemodynamic disturbances and small-focal necrotic processes in the liver and rumen, inflammatory catarrhal nature in the small intestine Novozhilov, 2008: 115-116).

In the zone with a catastrophic environmental situation, an increased amount of erythrocytes, leukocytes and lymphocytes, an increase in ESR and a sharp decrease in hemoglobin level were recorded in the blood of animals of the initial stage of fattening in the environment of the Cu, Pb, Cd, As and Cr (VI) compounds in the environment; a decrease in the concentration of ketone bodies, total protein and albumins with an increase in the γ-globulin fraction, an increase in the level of VFA, P-lipoproteins, and total cholesterol. After the animals were transferred to the conditionally clean zone, a change in the hemato-biochemical parameters toward their normalization was observed (Novozhilov, Katyukhin, 2008: 613-621).

For hematological researches selection of blood at animals is usually made in the morning before distribution of forages from a bulbar vein in sterile test tubes. For the purpose of prevention of fibrillation bring anticoagulant in test tubes – a heparin. For receiving serum of a test tube with blood leave for one hour at a temperature of 37-38 °C, then lead round and leave for settling. Then serum is selected in sterile test tubes and placed in the refrigerator (+4-5 °C).

Quantity of erythrocytes and leukocytes define in a cytometer of Goryaev. Erythrocytes count in five larger squares located on diagonals, leukocytes – in 100 larger squares across Kondrakhin (1985). Level of a hemoglobin is determined by a hemoglobin cyanide method with use of a photoelectrocolorimeter of CPC-2-UHL4.2 (the green light filter). The leukocytic formula is removed on dabs painted according to Romanovsky-Gimz under an immersion at a lens 90 *, an eyepiece of the 15th on the Biolam brand microscope.

In blood serum determine activity of the organospecific markers of cytolysis of hepatocytes – alanine aminotranspherase (ALAT) and aspartate aminotranspherase (ASAT) by a colorimetry method by Raymandu-Frenkel; the alkaline phosphatase (AP) – a colorimetry method; content of the common protein – a refractometry method; proteinaceous fractions – a turbidimetric method; glucose level – a glucose oxidative method; the common lipids – a colorimetry method by Ilka-Dadichu; beta lipoproteins – a colorimetric method by Burshteyn; a cholesterin – by Liberman-Burkharda's reaction in modification of Ilka-Dadicha; determination of calcium – complexometry with Arsenazo III indicator; inorganic phosphorus – by Bell-Doyz colorimetry with Yudenovich's modifications in Ivanovsky's version (Tuleukhanov, 2013: 327-331).

As an example we will consider researches on the level of content of heavy metals in blood of stylish cows.

As feeding of stylish cows in the considered farms is carried out at the expense of forages of characteristic production, high concentrations of lead, cadmium, nickel and zincum in vegetable sterns and water are a source of heavy metals in an organism of stylish cows.

The conducted researches of whole blood of the stylish cows who are contained in different ecological conditions showed that in blood of cows of one economy the level of lead exceeded maximum allowable concentration by 2,7 time, nickel – by 2,1 time, cadmium – for 36%. At a blood analysis of cows of other economy, there was excess with a maximum allowable concentration of lead at 14,0%.

Thus, the increased concentration of lead, nickel and cadmium in blood of stylish cows it will be agreed with their high content in the vegetable sterns entering a diet of animals of this economy.

Morphological and biochemical indexes of blood of stylish cows: the high concentrations of heavy metals found in blood of stylish cows were coordinated with changes of morphobiochemical composition of blood at these animals. So, at cows in various terms of stylishness the quantity of erythrocytes and level of a hemoglobin was reduced. The most expressed symptoms of anemia were noted on the sixth month of stylishness when the quantity of erythrocytes was below physiological norm for 47,0%, and hemoglobin level – for 21, 8%.

At cows the quantity of erythrocytes and level of a hemoglobin was in limits of physiological norm, at decrease in level of erythrocytes of blood on the sixth month of stylishness for 27,5% and a hemoglobin – for 4,9%.

The revealed anemia symptoms at stylish cows against the background of high concentration in blood of heavy metals demonstrate their toxic influence on an organism of stylish cows.

It was higher than leukocytes in blood of cows in one economy during the entire periods of researches, than at cows in other economy and exceeded physiological norm for 45,9%. The leukocytosis at the studied stylish cows, can be caused by a special physiological state (a leukocytosis of pregnant women) and also a reactivity of an organism against the background of toxic influence of heavy metals.

The leukocytic profile of blood of stylish cows was characterized by increase in quantity of eosinocytes. The most expressed eosinophilia was registered at animals at whom the maintenance of eosinocytes exceeded norm by 2,8 times.

At the same time, de Ritis's coefficient testifies about the morphofunctional damages of a liver of cows and a release of the organospecific markers of cytolysis of hepatocytes.

When determining level of the common protein and proteinaceous fractions at stylish cows the hypoproteinemia, generally due to decrease in level of γ-globulin fraction of protein is revealed that is explained by violation of synthetic function of a liver.

Developing on this hum noise of a hypoglycemia it will be agreed with change of level of an alkaline phosphatase which values are lower than reference sizes more than by 4 times, and cholesterin level in blood serum of stylish cows twice exceeds an upper bound of norm and reaches 8,02 ± 0,04 mmol/l.

In blood serum of cows of the first economy the content of the common calcium was below norm for 11,1%, and is higher than inorganic phosphorus – for 32,5%. In blood serum of cows of the second economy the content of the common calcium was in limits of norm, inorganic phosphorus was insignificant below norm, and the content of magnesium is 40,6% higher.

Thus, the morphobiochemical composition of blood of stylish cows demonstrates development of symptoms of intoxication in them – anemia, a leukocytosis and an eosinophilia, and also signs of damage of a liver, violation of mineral metabolism against the background of toxic influence of heavy metals.

Level of pollution of the soil, vegetable forages and water in the farms located in various ecological zones is non-uniform. The first economy the main pollutants is – lead, cadmium, zincum and nickel, their high content in the soil and water, good mobility promote intensive accumulation of these heavy metals in vegetable sterns: new-mown grass, silo and hay. In the second economy the main pollutant is lead which increased content was found both in the soil and water, and in vegetable sterns.

The increased level of heavy metals in the vegetable sterns entering a diet of animals will be coordinated with their high content in blood of stylish cows. Level of content of heavy metals in blood serum of stylish cows in the first economy is exceeded by the maximum allowable concentration (threshold limit value): on lead by 2,7 times, on nickel by 2,1 times, on cadmium by 1,36 times; in the second economy on lead – for 14,0%.

In a colostrum of cows from the first economy the content of lead exceeds maximum allowable concentration in 17,8, nickel – by 15,8 time, a cobalt – for 11,5%, and in a colostrum of cows from the second economy the content of lead – for 60%. The high level of pollution of a colostrum will be coordinated by heavy metals with low indexes of nutrition

value of a colostrum: it contains less nonvolatile solid, fat, the common protein, but it is more than lactose and the acidity is increased.

Heavy metals migrate on a chain «the soil – a stern, water – blood of stylish cows – a colostrum» and cause the essential morphofunctional changes which are characterized by change of morphological and biochemical composition of blood of stylish cows, deterioration of a colostrum and lag in body height and development of calfs in an organism of stylish cows (Ablaikhanova, 2013: 168-171).

Morphobiochemical composition of blood of the animals who are under the influence of technogenic pollution by heavy metals demonstrates development of symptoms of intoxication in them – anemia, a leukocytosis and an eosinophilia; signs of damage of a liver – increase in activity of aminotranspherases, disproteinemias, hypoglycemias, hypercholesterinemias, and also violation of mineral metabolism.

The biomarkers demonstrating toxic impact on an organism of animals and essential deterioration in an ecological condition of the environment are concentration of a hemoglobin, erythrocytes, leukocytes, CHE (the average content of a hemoglobin in one erythrocyte), CIB (color index of blood), ISL (index of shift of leukocytes), percent of neutrophilic myelocytes, neutrophilic metamyelocytes, stabnoid and segmented neutrophils, monocytes; major axis of erythrocytes, perimeter, area, erythrocyte ellipse shape factor; agglutination of erythrocytes, hemolysis, microcytic anemia, hypochromia, poikilocytosis, vacuolization of erythrocyte cytoplasm, leaching of erythrocyte nuclei, displacement of erythrocyte nuclei to the periphery of the cell (Atanbayeva, 2014: 53-58).

The reaction of the animal's blood system to the effects of copper, lead, cadmium and mercury ions is manifested primarily in the increase in the perimeter, area, small and large axes of erythrocytes, a decrease in the percentage of small and increasing the percentage of large lymphocytes, as well as changes in the leukocyte formula, morphology of red blood cells and depends from the type of metal, its concentration in water, the duration of exposure to the animals. High sensitivity to the influence of heavy metal ions of such animal blood parameters as the ratio of Er: L, the percentage of young erythrocytes, amitoses of erythrocytes, neutrophilic myelocytes, stabnuclear and segment neutrophils, lymphocytes, and small lymphocytes. The less sensitive parameters for the action of heavy metal ions are the concentration of Hb, Er, and especially the CHE. The degree of induced abnormalities in red and white blood is cadmium, followed by lead, copper and mercury: Cd> Pb> Cu> Hg% (Ablaikhanova, 2015: 182-187).

In most cases, regardless of type of chronic pollution, animals have similar changes in a blood picture: strengthening of a leukopoiesis with the shift of a leukocytic profile towards producing agranulocytes and increase of strength of an erythrogenesis against the background of an erythrohemolysis.

The direct dependence between intensity of toxic load of an organism of animals and quantity of leukocytes and also intensity of an erythrohemolysis is found.

Increase in frequency of occurrence of violations of morphology of formulated elements among which the vacuolation and nonuniform coloring of cytoplasm of erythrocytes, violation of a form of red cells are most widespread is noted. Much less often the anisocytosis and nuclear anomalies of erythrocytes meet (Ablaikhanova, Tusupbekova, 2016: 30-38).

Reaction of system of blood of animals to influence of ions of heavy metals has similarities, distinctions and is shown, first of all, in increase in perimeter, the area, small and big axes of an erythrocyte, decrease of percent small and increase in percent of larger lymphocytes and also emergence of amitotic division of erythrocytes, an anisocytosis, poikilocytosis, shadows of kernels, the destroyed erythrocytes, foamy cells. These parameters of blood can serve as pollution indicators heavy metals of natural ecosystems.

These are those hematological indicators of animals which at early stages fix negative changes in an organism and can serve as adequate model for assessment of adaptive opportunities of an organism at action of environmental factors, determination of quality of conditions of cultivation of animals. The common criteria of deterioration in a physiological condition of animals are reliable increase in percent of shadows of kernels, the index of elongation of erythrocytes, the relations Er:tr and decrease of a small axis of erythrocytes, surface areas of an erythrocyte, percent of thrombocytes and the relation Er:l. The percent of monocytes always is in standard conditions at a low level and significantly increases at the considerable deterioration in environmental conditions (deficiency of oxygen, strengthening of ammonia and ions of an ammonium, influence of ions of cadmium, anthropogenic pollution of a reservoir) (Ablaikhanova, Ablaikhanova, 2016: 30-39).

The possibility of application of the hematological method including a research of concentration and morphological indexes of red and white blood,

including cytometric parameters of erythrocytes as an element of biological monitoring is evidence-based. For a snap analysis of a physiological condition of animal and ecological conditions biomarkers which first of all reflect adaptive reactions of an organism of animals to change of ecological conditions, namely ISL, the relation Er:l, percent of foamy cells, the neytrophilic metamyelocytes, total number of neutrophils, small lymphocytes and also cytometric parameters of erythrocytes which can be determined automatically (Tusupbekova, Ablaikhanov, 2016: 132-139).

Thus, blood, being the internal environment of an organism, quickly and precisely reacts to changes of a surrounding medium, always and unmistakably reflects a physiological condition of an organism, demonstrating character and weight of an aberration. Fluctuations of indexes are bound to seasonal changes and physiological adaptation of an organism and also to toxic influence (Ablaikhanova, 2012).

Adaptation to the environment is noted at all levels of biological organization – behavioral, anatomical, physiological and biochemical. Ways of exercise of vital signs reflect external conditions which the look faces in physiological level. Changes in physiological mechanisms of various systems of an organism, including the system of blood, the quantitative relations of formulated elements of white and red blood, their morphology are the cornerstone of physiological adaptation.

Hematological researches have both theoretical, and practical value that is caused by the functional multivalence of system of blood and its high jet mobility. They find broad application in livestock production during the determining of a physiological condition of animals, evaluation test of forages, cultivation conditions, assessment of pathogenic influence of parasites and toxicants on animals (S. Sharypova, 2013a: 121)

Nevertheless, the works devoted to studying of indexes of blood of animals still cannot be considered numerous. This results from the fact that connection between the habitat of animals and their organism, indexes of their blood and a physiological condition, a sex, age, the course of pathological processes is not fully established. Hematological indexes in the diagnostic purposes when studying pollution of environments of dwelling of animals are extremely poorly used.

So far hematological indexes of animals are studied without sufficient accounting of a complex of the factors of the external environment considerably causing functioning of system of blood. At the same time the researches devoted to action of various technogenic factors on alive organisms are priority around the world now (Sharypova, 2013b: 125)

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